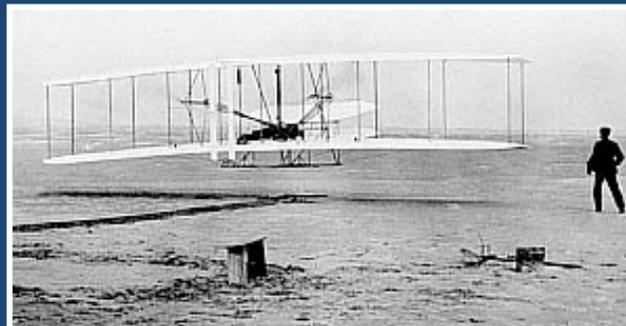


Masters Forum 17:

Celebrating 50 Years of NASA Exploration and Discoveries ---
Embracing a Future Enabled by a Legacy (28 October 2008)



About me

Private Sector: Aerospace and Technology 1998-Present

Director, NASA Dryden, 1990 - 98

Director of Engineering 1981 - 90

Research Engineer and First Line Supervisory Engineer 1964 - 81



60's



90's

Briefing on “Aeronautics”

Examples of flight research and test at the Dryden Flight Research Center that I lived through.

... and humble observations

NASA Dryden Flight Research Center on EAFB



Why Fly as Part of NASA's Aeronautics R&T Program?

**“ . . . separates the real from the imagined and
makes known the overlooked and the unexpected. . . ”**

Hugh L. Dryden

**“It is hard to design and airplane; much harder to build
one; but to fly is EVERYTHING”**

Otto Lilienthal

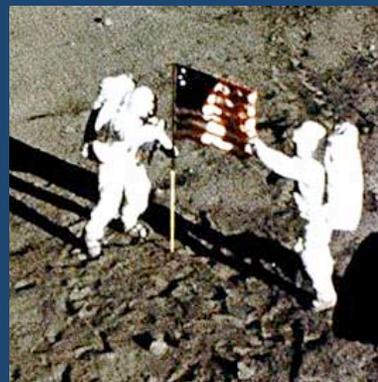
**“Flight programs make known the progress NASA is
making in its aeronautics program”**

Dale Compton (Former Ames Center Director)

Giants: Bikle, Dryden, Williams (1964)



Some Early Pioneers and Heroes in the Cockpit



A Few of the Brilliant People in the Labs and Offices I Was Honored to Work With

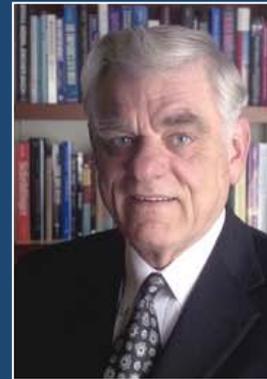
Dale Reed



Kenneth Iliff



Al Myers



Gus Guastaferrro



Marta Bohn-Meyer 1957-2005

To Fly...

0:01:00

Lunar Landing Research Vehicle

0:11:12

HiMAT

Remotely Piloted Research Aircraft

0:02:49

X-29

First Takeoff

0:09:31

X-31

Paris Airshow Maneuvers

0:14:26

Scale Model Parafoil Tests

0:12:36

Solar Powered Aircraft

Selected Projects

The F-8 DFBW— World's First Digital Fly-by Wire Aircraft Program

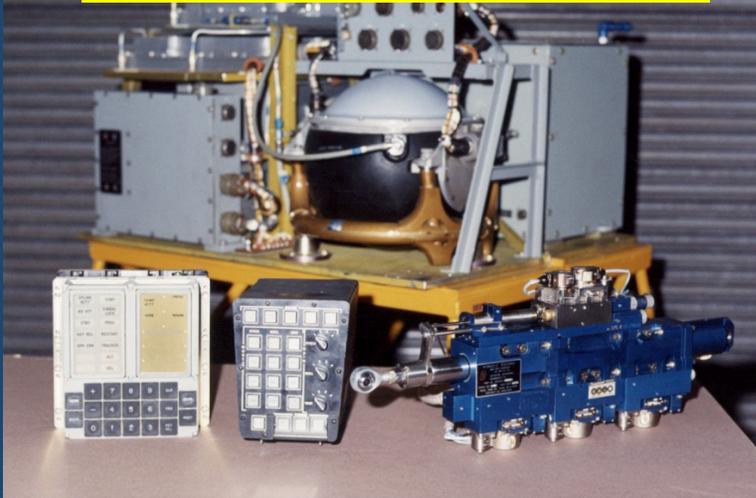
High Risk and Enormous Payoff and Impact



First Flight May 1972 Apollo System
Fault-Tolerant Triplex System Aug 1976

Gary E. Krier, Pilot, First Flight

Phase I Apollo DFBW System



Full Time, Full authority, All-axes DFBW System
Analog FBW Reversionary System (never used)
Mechanical FCS Removed Prior to 1st Flight
Direct Digital Design Phase II
Software Processes for Human Rated System
Advanced Control Laws
Flew Orbiter Sensor Software
Explored Pure FCS Time Delay after FF5 PIO

=====

MORE IMPORTANTLY

It unshackled designers from the limitations and constraints of natural stability and flying qualities for fighters, bombers, civil transports, spacecraft, solar aircraft, and spacecraft



Phase II Triplex DFBW System

0:16:10

Enterprise Flight #5
to EAFB RW 04

F-8 DFBW ^{0:16:50}

Testing for PIO

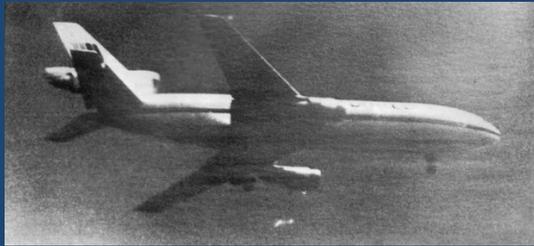
100 msec added
time delay

UA-232 Mishap in Sioux City

... an Idea is Developed

UA-232 Mishap in Sioux City

175 passengers and 10 crew members survived **Capt. Al Haynes, and Crew-Heros**



Loss of All
Aerodynamic
Control

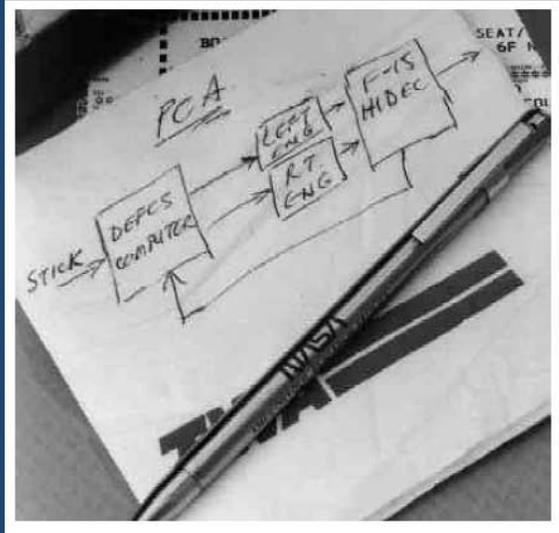


Crash
Landing

Aft Fuselage



Some Programs Start More Easily Than Others



Burcham's Initial Sketch

Bill Burcham

3/14/90

I want to develop the propulsion-enhanced flight control work as a NASA-led R&D program, with strong in-house technical and technology leadership

Glenn Galyard is very interested in this and could be lead on it. I want any the brief to be a technology one - given by either me, you, or Glenn, or someone TBD in controls.

Px schedule a mtg to go over brief content (me, DAD, R1P, GG, etc.)

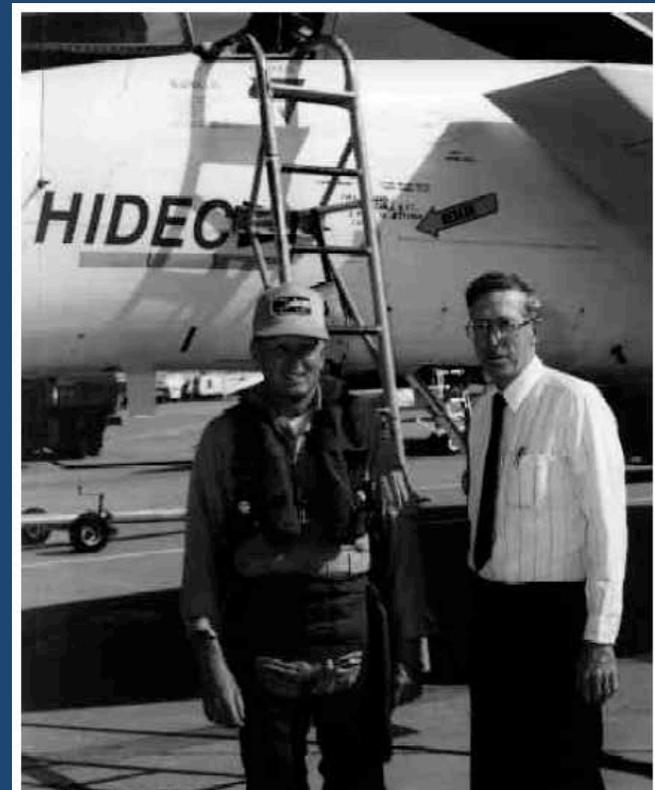
Kerr

Szalai Approves within Dryden.
Terry Neighbor, AFRL, Adds \$\$\$

Capt. Al Haynes Encouraged Us to Develop Propulsion-Controlled Aircraft System



NASA F-15 Landed with PCA System



“Gordo”
Fullerton,
Bill Burcham

0:05:26

F-15

Propulsion Controlled
Aircraft

Approach

0:06:17

MD-11

Propulsion Controlled
Aircraft

Approach

The High Angle of Attack Research Project



F-18 #6 Delivered
in NFAAC 80X160



F-18 HARV as Finished at DFRC



F-18



HARV 3-axis
Thrust Vectoring
System



HARV with Langley
Vortex Control

Langley (Lead)
Langley - CFD, High α
dynamics, spin tunnel,
wind tunnel,
Ames - CFD, wind tunnel
Dryden - Sim, Water tunnel
Dryden - F-18 HARV Flight

0:01:29

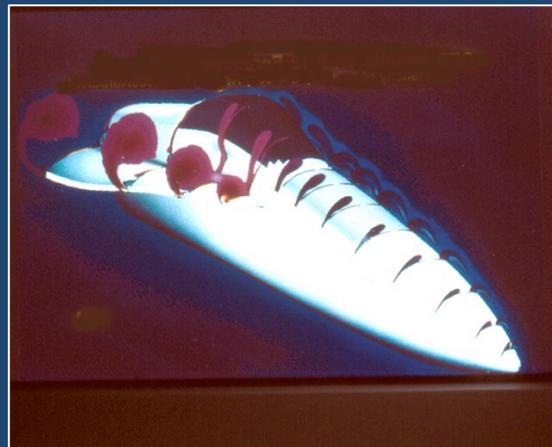
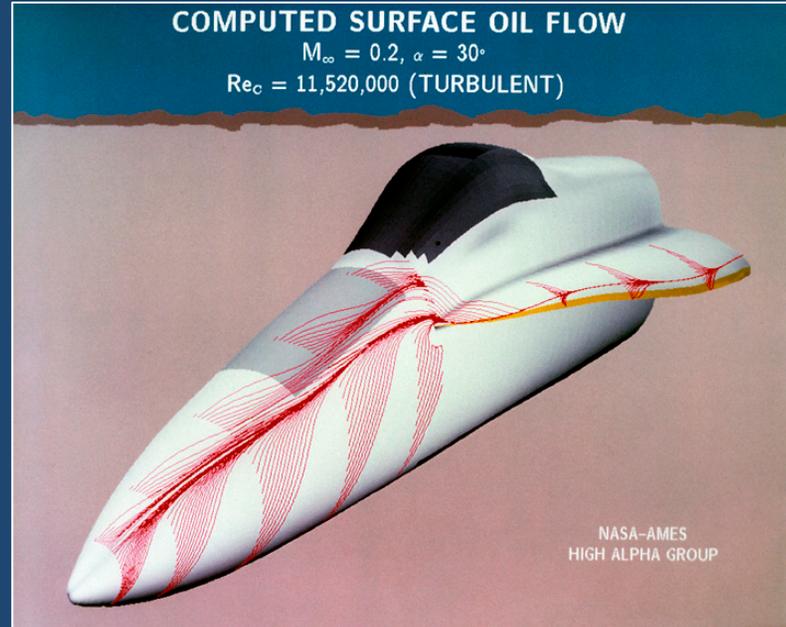
F-18 HARV

High Alpha Research Vehicle

Spin Test

Max Yaw Rate 90 deg/sec

Significant Discoveries and Technology



0:02:08

F-18 HARV

High Alpha Research Vehicle

Smoke Flow
Visualization



What Made The 3 Projects Important

✓ F-8 DFBW

A giant leap to a “world’s first” and discover what had to be done to make DFBW real for aircraft, and by doing it, the success was self-evident, with data to back it up

✓ Propulsion-Controlled Aircraft

Took a known concept and developed a new capability

✓ High Angle of Attack Program

Assembled CFD, wind tunnel, dynamicists, and flight teams to work on the same research at the same time. Major advance in high α prediction, thrust vectoring, safety, design.

Observations of Project Execution

- Extremely talented Project Managers and teams trained in the cauldrons of difficult high risk projects
- Most teams dominated by young people with 2–3 wiser, older team members
- Very small NASA Teams (F–8 DFBW < 20)
- Everyone at Dryden lived and breathed aircraft and safety
- Teams dominated by problem solvers
- HQ allowed for small failures
- Teams had endless energy, passion, intensity
- Managers were leaders

Why Fly...in Retrospect

Flight is nature's truth serum and lie detector for our ideas about aircraft and systems.....

*Flight research is not “validation”, **it is discovery**, and often, “invalidation”*

In flight programs you solve the real problems, integrate pilot and systems, make credible predictions, understand every anomaly, put your career and lives on the line, and transfer technology with data and by flying

K. Szalai 28 October 2008

Complaint I Often Hear

Too much work...too few people

Mid 60's



Assertion I Often Hear

It takes a long time to fully
expand the
Envelope of a complex vehicle

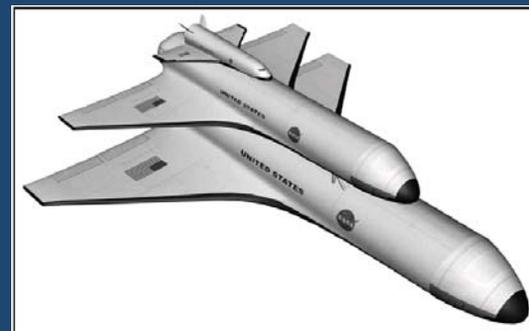


X-15 First Flight with XLR 99 22 Nov 1960
(Mach 2.97 / 82,500 ft)

Design Speed Flight 9 Nov 1961 11 months
(Mach 6.04 101,400 ft)

Design Altitude Flight 30 30 April 1962 18 months
(246,700 ft Mach 4.94)

What Do These Have In Common?

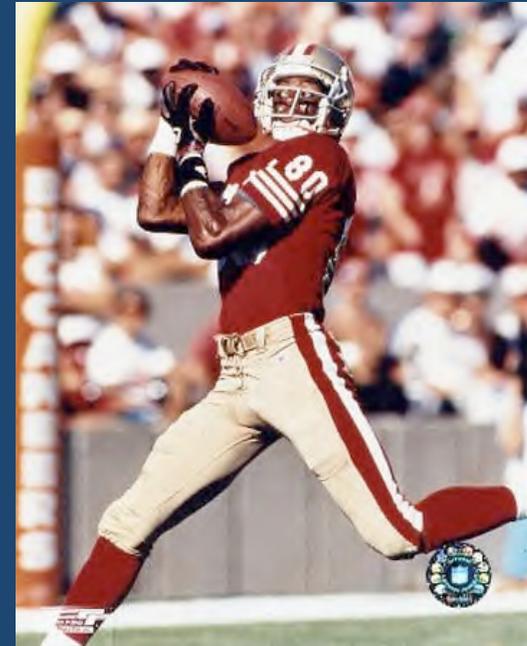


... and
these?



Wednesday October 22, 2008
St. Petersburg Times

Singletary Takes Over 49ers
From Fired Nolan



Jeb York son of owner John York said " the 49ers **lack passion** and intensity, we are not getting outplayed. I think we are getting out intensified..... there is no doubt that we have talent.... what we are lacking right now is that killer instinct, that **FINISHING ABILITY**

If flight research capability is lost within NASA,
and experimental vehicles 'fly only on poles'



then NASA won't be able to do these either



I am very lucky, and am blessed - - a loving family, great colleagues, great bosses, and great challenges.

I had the time of my life in NASA.







The F-8 PIO Incident

- ✓ Thorough hazards analysis (prior to matrix)
- ✓ Safety features added to recover from worst case
- ✓ Encountered worst case, but not in approach
- ✓ **Pilot 1** waved off (PR=10)
- ✓ **Pilot 2** took hands off in approach (PR=5)
- ✓ **Pilot 3** stayed in the loop during entire task
- ✓ MCC and pilot action was as practiced by “tight” team
- ✓ F-8 only “test” that replicated FF5 PIO
- ✓ PIO suppression filter invented at DFRC – installed in STS

And here are just some of the rest ...



**Airborne Simulation
Laminar Flow
Advanced Turboprop noise**



Supercritical Wing



X-29 wd Swept Wing



**Supersonic Laminar
Flow Control**



HiMAT UAV



100K FT- on sunpower



X-43 SCRAMJET - Mach 10

0:00:26

M-2 F-1